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Indian Standard

IS 1118 : 2019

बहुउद्देशीय गियर स्नेहक (अतिरिक्त दबाव गियर तेल) — विशिष्टि

(दूसरा पुनरीक्षण)

Gear Lubricants, Multipurpose (Extreme Pressure Gear Oil) — Specification

(Second Revision)

ICS 75.100

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Lubricants and their Related Products Sectional Committee, PCD 25

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards after the draft finalized by the Lubricants and their related products Sectional Committee had been approved by the Petroleum, Coal and Related Products Division Council.

This standard was originally published in 1957 covering gear lubricants based on the prevailing U.S. Military Specification MIL-L-2105 and the U.K. Military of Supply Specification CS 2758. The standard was revised in 1992 for the first time covering gear lubricants based on the then prevailing U.S. Military, U.K. Military of Supply and API standards. The oils were classified as extreme pressure (EP) oils under two different performance levels, which correspond to different applications.

IS 1118-92 Standard Type	**Equivalent Performance**
EP Type GL-4	MIL-L-2105B/API GL-4/ CS: 3000A
EP Type GL-5	MIL-L-2105D/API GL-5/ CS: 3000B

Performance test facilities for qualifying EP type GL-4 and EP type GL-5 oils are not presently available in India. For the purpose of qualifying oils against EP type GL-5, facilities available in the approved overseas laboratories are expected to be utilized till such times these or equivalent tests are established in the country. However, for guaranteeing the quality, only oils with at least half the dosage of the GL-5 approved additive package has been allowed.

Over the last two decades, the U.S. Military, U. K. Military and API GL-5 specifications underwent considerable changes. This revision (second) intends to incorporate the key changes based on the developments in gear oil specification.

IS 1118-revised Standard Type	**Global Equivalent Performance**
EP Type API GL-4	API GL-4 (50 percent treat level of API GL-5)
EP Type API GL-5	API GL-5 (ASTM D7450)

The MIL-L-2105D specification was upgraded to MIL-PRF-2105E (1995 version) which was later re-written as SAE J2360 (2005 version). Now, since the industry has moved from MIL-L-2105D to SAE J2360, the performance level needs to be classified under a specification above API GL-5 and would need additional performance requirements on thermal stability and seal compatibility besides field-testing of new additive systems and/or unique base stocks along with review by SAE PRF committee. As this revision is focused on API GL-5 performance level, the upgraded MIL-PRF-2105E (SAE J2360) specification needs to be decoupled from the existing specification. Performance tests to qualify API GL-5 was upgraded from ASTM STP 512A to ASTM D7450.

For newer additives and lubricants, the EP Type API GL-5 qualification need to obtain by running all the tests as per ASTM D7450. The previous qualified lubricants must have historical data as per ASTM STP 512A / STP 512. All the ASTM qualification tests must be or must have been run at a qualified laboratory that has been calibrated and being monitored by the ASTM Test Monitoring Centre. This is to ensure that all test stands at all laboratory are running correctly and are operating at the appropriate levels of severity.

Performance test facility for qualifying EP type API GL-4 is now obsolete. As a result, in order to ensure the erstwhile API GL-4 level of performance for certain applications, lubricant oils with half dosage (that is, 50 percent) of the approved EP Type API GL-5 additive is the only allowable EP Type API GL-4 in this revision. This is based on industry wide experience to ensure appropriate hardware protection.

The other main aspect of the revision relates to the viscosity classification of automotive gear oils which has been revised to SAE J306 (2005 version). The SAE J306 includes a 20 h shear stability requirement as per CEC L-45-A-99 and low temperature property as per ASTM D2983.

(*Continued on third cover*)

Indian Standard

GEAR LUBRICANTS, MULTIPURPOSE (EXTREME PRESSURE GEAR OIL) — SPECIFICATION

(Second Revision)

1 SCOPE

1.1 This standard prescribes the requirements and methods of sampling and test for the various types of multipurpose automotive gear lubricating oils [extreme pressure (EP) type].

1.2 The lubricant is primarily intended for use in automotive hypoid gear units, manual transmissions, final drives, steering gears and fluid lubricated universal joints of automotive equipment.

WARNING — The use of this standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the users of this document to take appropriate measures to ensure the safety and health of personnel prior to the application of the standard, and to determine the applicability of any other restrictions for this purpose.

2 REFERENCES

The following standards contain provisions which through reference in this text, constitute provisions of the standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on these standards are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
1447 (Part 1) : 2000	Petroleum and its products — Methods of sampling: Part 1 Manual sampling
1448	Methods of tests for petroleum and its products
[P : 15] : 2004/ ISO 2160 : 1998	Petroleum products — Corrosiveness to copper — Copper strip test (*third revision*)
[P : 16] : 2014/ ISO 3675:1998	Density, relative density or API gravity of crude petroleum and liquid petroleum products by hydrometer method (*third revision*)
[P : 25/Sec 1] : 2018/ ISO 3104 : 1994	Transparent and opaque liquids, Section 1 Determination of kinematic viscosity and calculation of dynamic viscosity (*second revision*)
[P : 33] : 1991	Sulphur by bomb method (*second revision*)
[P : 50] : 1977	Chlorine in new and used lubricants sodium alcoholate method (*second revision*)
[P : 54] : 2017	Lubricating oils and additives — Determination of phosphorus content — Quinoline phosphomolybdate method (*second revision*)
[P : 56] : 2013/ ISO 2909 : 2002	Viscosity index by calculation (*second revision*)
[P : 67] : 1982	Foaming characteristics of lubricating oils (*first revision*)
[P : 69] : 2013/ ISO 2592 : 2000	Determination flash and fire points — Cleveland open cup method (*first revision*)
[P : 120] : 1986	Zinc in lubricating oil

3 CLASSIFICATION

3.1 Types

The oils shall confirm to one of the following 11 mono viscosity grades as distinguished by the viscosity limits prescribed below:

a) EP type GL-4, and
b) EP type GL-5.

3.2 Viscosity Grade

The SAE J306 specification is a definition applied to finished lubricants and reflects only the viscosity grade of the fluid. The details of the viscosity classifications are provided below.

SAE Viscosity Grade	Maximum Temperature for a Viscosity of 1 50 000 cP (°C)[1]	Kinematic Viscosity at 100°C (mm^2/s)[2]	
		Min[3]	*Max*
70W	-55	4.1	—
75W	-40	4.1	—
80W	-26	7	—
85W	-12	11	—
80	—	7	<11.0
85	—	11	<13.5
90	—	13.5	<18.5
110	—	18.5	<24.0
140	—	24	<32.5
190	—	32.5	<41.0
250	—	41	—

[1] Using ASTM D2983.

[2] Using ASTM D445.

[3] Limit must also be met after testing in CEC L-45-A-99, Method C (20 h).

3.3 The oils may also be multi-grade combination of winter and summer grades for example, SAE 75W-90, SAE 80W-90, SAE 85W-140 etc. In such cases, oil shall comply with the winter grade Brookfield requirement and kinematic viscosity at 100°C requirement of a summer grade. Furthermore, the finished fluid viscosity after shearing in the 20 h KRL test as per CEC L-45-A-99 must be higher than the lowest permitted for the given grade. Example: For an SAE 75W-90 grade, fluid must have Brookfield Viscosity at -40°C of < 150,000 cP, and Kinematic Viscosity at 100°C between 13.5 and 18.5 mm^2/s shall have kinematic viscosity at 100° $\geq$13.5 mm^2/s after KRL shear.

3.4 Approved Performance Tests

The tests for performance evaluation of oils are summarized below:

Type of Oil	Approved Performance Tests
EP Type API GL-5	a) ASTM D7452 (formerly L-42)
	b) ASTM D6121 (formerly L-37) using non-lubricated hardware
	c) ASTM D7038 (formerly L-33-1)
	d) ASTM D5704 (formerly L-60-1) or L-60
	e) ASTM D892
	f) ASTM D130

4 REQUIREMENTS

4.1 General

The gear lubricating oils shall be homogeneous and shall be formulated using mineral lubricating oil base stock (virgin or re-refined or combination thereof), a synthetically prepared product, or a combination of the two types of products compounded with such functional additive materials like viscosity index improvers, pour point depressants, oxidation and corrosion inhibitors, extreme pressure agents, antiwear additives, antifoamants, etc, as are necessary to meet the specified requirements of the standard.

4.2 Physico-chemical Requirements

4.2.1 *Requirements for Finished Oil*

The oil shall be free from suspended matter, grit water or any other impurities. The oil shall also comply with physico-chemical requirements prescribed in Table 1 and **4.2.2** and **4.2.3**.

4.2.2 *Homogeneity and Miscibility, Compatibility and Storage Stability of Finished Lubricating Oils*

4.2.2.1 *Homogeneity and miscibility*

The finished blended oil shall have the additive elements uniformly distributed throughout the oil and shall show no evidence of instability at temperature specified in the homogeneity and miscibility test described in Annex A.

4.2.2.2 *Compatibility*

The oil shall be compatible with all other oils previously qualified under this standard as demonstrated by the compatibility test described in Annex B. The compatibility is determined by subjecting separate mixtures of the oil with six selected reference oils designated by qualifying authority.

4.2.2.3 *Storage stability*

The oil shall satisfactorily pass the storage stability test as described in Annex C.

NOTE — Homogeneity and miscibility (**4.2.2.1**), compatibility (**4.2.2.2**) and storage stability (**4.2.2.3**) tests are type tests for defense applications. For other applications, these may be mutually decided by supplier and user.

4.3 Requirements of the Base-Stock

4.3.1 The maximum viscosity index of the base-stock used in formulating the gear oil shall be not less than 85.

Table 1 Physico-Chemical Requirements of Gear Lubricant, Multipurpose, EP Types GL-4 and GL-5

(*Clauses* 4.2.1 *and* 7.2)

Sl No.	**Characteristic**	**Requirements for Grade**											**Methods of Tests, Ref to**
		SAE 70 W	SAE 75 W	SAE 80 W	SAE 85 W	SAE 80	SAE 85	SAE 90	SAE 110	SAE 140	SAE 190	SAE 250	IS 1448 / Annex
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
i)	Appearance	When examined in transmitted light in a colourless glass test tube of 25 mm diameter, the oil shall be clear, bright and free from turbidity and sediment											—
ii)	Kinematic Viscosity, mm²/s at 100 °C	4.1, *Min*	4.1, *Min*	7.0, *Min*	11.0, *Min*	7.0 to 11.0	11.1 to 13.5	13.6 to 18.5	18.6 to 24.0	24.1 to 32.5	32.6 to 41.0	41.1, *Min*	[P : 25/Sec 1]
iii)	Maximum temperature for Brookfield viscocity of 1 50 000 cP, °C	-55	-40	-26	-12	—	—	—	—	—	—	—	ASTM D 2983
iv)	Viscosity index, *Min*	85	85	85	85	85	85	85	85	80	80	80	[P : 56]
v)	Flash point, °C, (cleveland open cup), *Min*	150	150	165	180	180	180	180	180	190	190	200	[P : 69]
vi)	Copper strip corrosion, *Max*												[P : 15/ASTM D 130]
	a) Max/ EP type GL-4, 121 °C for 1 h	Not more than 2											
	b) EP type GL-5, 121 °C for 3 h	Not more than 3											
vii)	Foaming characterstics/ tendency/ stability												[P : 67/ASTM D 892]
	a) at 25 °C, *Max*	20/Nil											
	b) at 93 °C, *Max*	50/Nil											
	c) at 24 °C, after the test at 93 °C, *Max*	20/Nil											

4.3.2 Each base-stock component used in formulating the finished oil shall be accompanied by the following property data. Properties to be reported:

a) Kinematic viscosity at 40°C and 100°C in mm^2/s;

b) Viscosity index;

c) Flash point, °C;

d) Conradson carbon residue, percent by mass;

e) Sulphated ash, percent by mass;

f) Water content, percent by volume;

g) Total acid number;

h) Pour point, °C;

j) Sulphur content, percent by mass; and

k) Colour.

4.4 Performance Test Requirements

4.4.1 *EP-Type GL-5 Oils* (*see* Table 2)

Table 2 API Category GL-5 Tests and Acceptance Criteria

(*Clauses* 4.4.1 *and* 7.2)

Sl No	Characteristic	Requirement	
		Minimum	*Maximum*
i)	Test Method D7452 (formerly L-42) [1),2)]	—	
	a) Percent scoring, pinion		
	b) Drive side		Equal to or better (lower) than the mean scoring values of the passing reference oil test results used to calibrate the stand
	c) Coast side		
	d) Percent Scoring, Ring		
	e) Drive Side		
	f) Coast Side		
ii)	Test Method D6121 (formerly L-37) using non-lubricated hardware [2),3)]		
	a) Ridging, ASTM Merit rating	8	—
	b) Rippling, ASTM merit rating	8	—
	c) Wear, ASTM merit rating	5	—
	d) Pitting/ spalling, ASTM merit rating	9.3	—
	e) Scoring, ASTM merit rating	10	—
iii)	Test Method D7038 (formerly L-33-1)[4)]		
	a) Final rust merit rating	9.0	
iv)	Test Method D5704[5)] (formerly L-60-1) or L-60		
	a) Viscosity increase, percent	—	100
	b) Pentane insoluble, weight percent	—	3.0
	c) Toluene insoluble, weight percent	—	2.0
v)	Test Method D892, tendency		
	a) Sequence I, ml	—	20
	b) Sequence II, ml	—	50
	c) Sequence III, ml	—	20
vi)	Test Method D130[6)]		
	ASTM rating	—	3

[1)] The Canadian version of the ASTM D7452 test follows the procedure of the ASTM D7452 test with the modification in Annexure 1, Table A 1.1 of that standard.

[2)] This test may be conducted under two different sets of operating conditions, commonly referred to as Standard and Canadian. The test condition to be used are dependent upon the viscosity grade of the lubricant under evaluation. Please *see* Table 3 for details as to which version of the test should be used in the evaluation of a specific lubricant.

[3)] The Canadian version of the ASTM D6121 test follows the procedure of the ASTM D6121 test with the modifications in Annex A-6.2, Table A-6.1 of that standard.

[4)] Candidate fluids tested previous to the development of the ASTM D7038 test procedure using the L-33 test procedure with a cover plate merit rating of a minimum of 8 and a merit rating for all other areas of a minimum of 10 are considered acceptable results against performance requirements of this specification.

[5)] Carbon or varnish and sludge ratings are reported in the ASTM D5704 test procedure but are not an acceptance criterion for API Category GL-5.

[6)] Tested for 3 h at 121°C.

5 PRODUCT IDENTIFICATION

To ensure acceptance of only qualified products and for the purpose of product identifying, test may be carried out by the purchaser or his agency on the characteristics of the oil and the test results shall be compared with the corresponding figures given in the product identification report. Permissible tolerances of test results are indicated against each of the characteristics as given in Table 4.

6 PACKING AND MARKING

6.1 Packing

The material shall be packed in metal containers or in any other suitable containers as agreed to between the purchaser and the supplier.

6.2 Marking

6.2.1 The containers shall be securely closed and marked with the following information:

a) Indication of the source of manufacture, recognized trade-mark, if any;
b) Name, type and grade of the material;
c) Net mass of the material; and
d) Identification in code or batch number or otherwise to enable the lot of consignment or manufacture to be traced back from records.

6.2.2 All marking including batch number of lot of manufacture shall be made on one flat end when the material is packed in barrels.

Table 3 API Category GL-5 Testing Requirements According to the Viscosity Grade of the Candidate Gear Lubricant

[*Clause* 7.2, *Table* 2, (*Note* 2)]

Sl No. (1)	Test Method (2)	SAE 70W and SAE 75W (3)	SAE 70W-XX and SAE 75W-XX[1)] (4)	All Other SAE Viscosity Grades (5)
i)	Standard Version of Test Method D7452 (formerly L-42)	Not Required	Required	Required
ii)	Canadian Version of Test Method D7452 (formerly L-42)	Required	Required	Not Required
iii)	Standard Version of Test Method D6121 (formerly L-37)	Not Required	Required	Required
iv)	Canadian Version of Test Method D6121 (formerly L-37)	Required	Required	Not Required
v)	Test Method D7038 (formerly L-33-1) or L-33	Required	Required	Required
vi)	Test Method D5704 (formerly L-60-1) or L-60	Required	Required	Required
vii)	Test Method D892, tendency	Required	Required	Required
viii)	Test Method D130	Required	Required	Required

NOTE — XX : May be 80, 85, 90, 110, 140, 190, or 250 as indicated in SAE J306.

Table 4 Permissible Tolerances for Qualification

(*Clauses* 5 *and* 7.2)

Sl No. (1)	Characteristic (2)	Tolerance (3)	Methods of Test, Ref to IS 1448/Annex (4)
i)	Relative density	To be reported	[P : 16]
ii)	Flash point, ºC (COC)	*Minimum* as specified	[P : 69]
iii)	Temperature for Brookfield viscosity of 1 50 000 cp, ºC	-do-	ASTM D 2983
iv)	Kinematic viscosity, mm^2/s at 100ºC	*Within the range* specified	[P : 25/Sec 1]
v)	Viscosity index	*Minimum* as specified	[P : 56]
vi)	Sulphur, percent by mass	± 20 percent	[P : 33]
vii)	Phosphorus, percent by mass	-do-	[P : 54]
viii)	Chlorine, percent by mass	-do-	[P : 50]
ix)	Zinc, percent by mass	-do-	[P : 120]

6.2.3 *BIS Certification Marking*

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed thereunder, and the products may be marked with the Standard Mark.

7 SAMPLING

7.1 Representative samples of the material shall be drawn as prescribed in IS 1447 (Part 1).

7.2 Number of Tests

Tests for all the characteristics given in Table 1 and 4 of the specification shall be conducted on the composite sample.

7.3 Criteria for Conformity

The lot shall be declared as conforming to this specification, if all the test results on the composite sample satisfy the requirements of this specification.

ANNEX A

(*Clause* 4.2.2.1)

HOMOGENEITY AND MISCIBILITY TEST

A-1 GENERAL

This test determines whether an oil is and will remain homogenous and whether it is miscible and be stable when blended with certain standard oils after being submitted to a prescribed cycle of temperature changes.

A-2 SAMPLE

A-2.1 Test Sample — Approximately 300 ml.

A-2.2 Standard Reference Oils — As approved by the qualifying authority.

A-3 APPARATUS

A-3.1 Test Jar, of clear glass, cylindrical form, flat bottom, approximately 30 to 35 mm in inside diameter and 115 to 125 mm in height.

A-3.2 Thermometer, -38 to +50ºC range with 1.0ºC graduations, 230 mm long and 108 mm immersion.

NOTE — ASTM 5C or equivalent may be used.

A-3.3 Cork, to fit the test jar, bored centrally to take the test thermometer.

A-3.4 Jacket, Glass or metal, water-tight, of cylindrical form, flat bottom, about 115 mm in depth, with inside diameter 9.5 to 12.5 mm greater than the outside diameter of the jar.

A-3.5 Disk, cork or felt, 6 mm in thickness of the same diameter as the inside diameter of the jacket.

A-3.6 Gasket, a ring gasket, about 5 mm in thickness, to fit snugly around the outside of the test jar and loosely inside the jacket. The purpose of the ring gasket is to prevent the test jar from touching the jacket.

A-3.7 Bath, a cooling bath of a type suitable for obtaining the required temperature.

A-4 PROCEDURE

A-4.1 Shake oil sample well and pour into six sample jars to the 37.5 mm mark and one sample jar to the 75 mm. Add a reference oil to each of the sample jars to the 75 mm mark. Mix the oils thoroughly and heat to 46 ºC in water bath. After the oils reach room temperature, observe and record the colour and evidence of separation. Determine and record the pour point of each oil.

A-4.2 Maintain the temperature of the cooling bath at -1 to +2ºC. Support the jacket, containing the test jar, firmly in a vertical position in the cooling bath so that not more than 25 mm of the jacket projects out of the cooling medium.

A-4.3 Beginning at a temperature 12ºC before the expected pour, at each test thermometer reading that is a multiple of 3ºC, remove the test jar from the jacket carefully and tilt it just enough to ascertain whether there is a movement of the oil in the test jar. The completed operation of removal and replacement shall require not more than 3 s. If the oil has not ceased to flow when its temperature has reached 10ºC, place the test jar in the jacket in a second bath maintained at a temperature of -18 to -15ºC. If the oil has not ceased to flow when its temperature has reached -7ºC, place the test jar in the jacket in a third bath maintained at a temperature of -34.5ºC. For determinations of very low pour point, additional bath should be maintained with successively lower temperature differentials of about 17ºC. In each case, transfer the test jar when the temperature of the oil reaches a point of 28ºC, above the temperature of the new bath. At no time, place the cold test jar directly in the cooling medium. As soon as the oil in the test jar in a horizontal position for exactly 5 s, as noted by a stopwatch or other accurate timing device, and observe carefully. If the oil shows any movement under these conditions, place the test jar immediately in the jacket and repeat a test for flow at the next temperature 3ºC lower.

A-4.4 Continue the test in this manner until a point is reached at which the oil in the test jar shows no movement when the test jar is held in a horizontal position for exactly 5 s. Certain lubricating oils tend to move as a whole and should be very closely observed. Record the reading of the test thermometer at this temperature, corrected for error, if necessary. Allow the samples to thaw; and when the cloudiness has barely disappeared, observe and record the colour and evidence if separation. When the samples reach room temperature, place them in an oil-bath after removing the thermometers. Heat the bath at 230ºC and immediately remove the sample jars. Cork the samples and store them at their respective pour points for 18 to 24 h. Remove the jars and allow the sample to thaw.

When cloudiness has barely disappeared, observe and record the colour and evidence of separation. Repeat the last operation when the samples reach room temperature.

A-5 REPORTING

A-5.1 Report evidence of separation in the following four successive stage:

a) Initial sample;
b) Warmed to just above cloud after having once reached pour point;
c) After a cycle of heating to 230°C cooling to pour point, storing it for 24 h at this temperature and warming to just above pour point; and
d) Warmed to room temperature.

A-5.2 Evidence of separation is to be reported as:

a) *Condition:*
    1) Definite, and
    2) None of doubtful.
b) *Location:*
    1) Near top,
    2) Near bottom,
    3) Filament, and
    4) Uniformly distributed.
c) *Particle Size:*
    1) Small, as in cloud or haze, and
    2) Specks or larger particles.
d) *Colour:*
    1) White of very light,
    2) Yellow, and
    3) Black.

ANNEX B

(*Clause* 4.2.2.2)

COMPATIBILITY TEST

B-1 GENERAL

This method is used for determining the compatibility of universal gear lubricant when blended with a reference gear lubricant by observing for precipitation of additive material after storage.

B-2 APPARATUS

B-2.1 100 ml cone shaped centrifuge tubes.

B-2.2 Centrifuge with a diameter of swing (tip-to-tip of whirling tubes) 375 to 425 mm and hall be capable of being controlled at a speed of 1 500 ± 25 rpm.

NOTE — If the available centrifuge does not conform dimensionally to be preferred form, the speed, rotation or the available centrifuge must be adjusted 10 given the same centrifugal force at the tips of the tubes as that obtained with the prescribed instrument when operated at 1 500 ± 25 rpm. The speed to operate the available centrifuge shall he calculated front the formula:

$$rpm = 1500\sqrt{\frac{16}{d}}$$

where,

d = the diameter of the swing (tip-to-tip of whirling tubes) of the available centrifuge.

B-2.3 Balance capable of weighing to 1 mg.

B-2.4 Constant temperature bath capable of being controlled at 121 ± 1°C (250 ± 2°F).

B-2.5 Stirring apparatus capable of stirring the contents of a 400 ml tall form beaker at approximately 200 rpm.

B-2.6 Beaker, 400 ml capacity, tall form, heat resistant glass.

B-2.7 Forced circulation oven capable of being controlled at 104.4 ± 2°C (220° ± 5°F).

B-2.8 Desiccator, capable of holding several centrifuge tubes.

B-2.9 Graduated cylinders, 100 ml capacity.

B-3 MATERIALS

B-3.1 Naphtha

B-3.2 Cleaning Solution, consisting of concentrated sulphuric acid saturated with potassium dichromate.

B-3.3 Distilled Water

B-3.4 Denatured Ethyl Alcohol

B-3.5 Reference Oils, as approved by the qualifying authority.

B-4 PROCEDURE

B-4.1 Make two compatibility tests with each reference oils.

B-4.2 Determine the residue in each of the reference oils and the sample oil by subjecting each of the reference oils alone (not mixed with any other oil) to the procedures described in **B-4.7** through **B-4.16**.

This data will be used in calculations of compatibility (**B-4.17**).

B-4.3 Preparation of Centrifuge Tubes

Prepare two centrifuge tubes for test with each reference oil.

B-4.4 Support the centrifuge tubes in an inverted position in an oven maintained at 104.4 ± 1ºC (220º ± 2ºF) for at least one-half hour.

B-4.5 Remove the tubes from the oven, place them in a desiccator, and permit them to cool to room temperature.

B-4.6 Number each tube, weigh to the nearest milligram, and replace tubes in the desiccator until they are to be used.

B-4.7 Thoroughly shake sample and reference oils prior to sampling.

B-4.8 Use 110 ml of reference and test oils.

B-4.9 Heat the beakers containing the reference and test oils in an oven at 121.1 ± 1ºC for 20 min. Remove the beakers from the oven and stir (with a mechanical stirrer) the contents while still hot for 5 min.

B-4.10 Transfer 100 ml of the contents of each beaker to weighed centrifuge tubes. Save the remainder of the oil mixture.

B-4.11 Cork the centrifuge tube and store it in an upright position in a darkener, such as a drawer or cupboard at room temperature for a period of 30 ± 1 days.

B-4.12 At the conclusion of the storage period remove the centrifuge tube from the storage area, place it in the centrifuge, and operate the centrifuge at 1500 ± 25 rpm for a period of 30 ± 1 min.

NOTE — In transferring the centrifuge tube from the storage area to the centrifuge, care must be taken not to disturb any material which may have separated from the oil.

B-4.13 Remove the centrifuge tube from the centrifuge and decant and discard the supernatant oil. Permit the centrifuge tube to drain in an inverted position at room temperature for a period of two hours. Discard the draining. If the residue is a solid, wash it with naphtha sufficient number of times to ensure that it is free of oil.

NOTE — If the separated material is not sufficiently compacted by the centrifuge to permit decanting the supernatant oils, continue the centrifuging for 15 min intervals until decanting is possible. If the material is a liquid at the conclusion of 30 min centrifuging period, or if it cannot be compacted, stopper the centrifuge tube and replace it in storage for an additional 30 days. At the end of the second storage period, proceed as directed in **B-4.12**.

B-4.14 Place the centrifuge tube in an upright position in an oven controlled at 104.4 ± 1ºC (220 ± 2ºF) for approximately 2 h.

B-4.15 Remove the centrifuge tube from the oven and place it in a desiccator to cool to room temperature. Weigh the tube and contents to the nearest milligram. Subtract the weight of the empty centrifuge tube to determine the weight of the separated material.

NOTE — If the residue remains a liquid at the end of the second 30 days storage period, centrifuge the tube as specified in **B-4.12**. Remove the tube from the centrifuge and note the volume of the separated liquid to the nearest 0.05 ml.

B-4.16 Pour the remainder of the oil remaining in the 400 ml beaker (approximately 100 ml, *see* **B-4.9**) into a second 400 ml beaker and examine the beaker in which the oils were mixed for sludge or other evidence or incompatibility.

B-4.17 Report

Calculate the percent incompatibility for each reference oil as an average of the values obtained for each reference oil using the following formula:

Theoretical zero incompatibility = $R + T$

Evidence of incompatibility = $X - (R + T)$

$$\text{Percent incompatibility} = \frac{X - (R + T)}{0.9\,(50\,\text{r} + 50\,\text{r})} \times 100$$

Where,

R = weigh separated material in reference oil (g/50 ml of oil), *see* **B-4.2**;

T = weigh of separated material in sample oil (g/50 ml of oil), *see* **B-4.2**;

X = weigh of separated material found in compatibility test, *see* **B-4.16**;

r = weigh percent of additive in reference oil (to be supplied by the supplier of the reference oil);

t = weigh percent additive in sample oil (to be supplied by the manufacturer of the sample oil); and

0.9 = assumed specific gravity of both reference oil and sample.

NOTE — It may be of interest to make a chemical analysis of the residue found in the incompatible oil mixture.

ANNEX C

(*Clause* 4.2.2.3)

DETERMINATION OF STORAGE STABILITY

C-1 GENERAL

This method is used for determining the storage solubility characteristics of universal gear lubricants.

C-2 APPARATUS

C-2.1 100 ml cone-shaped centrifuge tubes.

C-2.2 Centrifuge with a diameter of swing (tip-to-tip whirling tubes) 375 to 425 mm and shall be capable of being controlled at a speed of 1500 ± 25 rpm.

> NOTE — If the available centrifuge does not conform dimensionally to be preferred form, the speed of rotation of the available centrifuge must be adjusted to give the same centrifugal force at the tips of the tubes as that obtained with the prescribed instrument when operated at 1 500 ± 25 rpm. The speed to operate the available centrifuge shall be calculated from the formula:
>
> $$rpm = 1500\sqrt{\frac{16}{d}}$$
>
> where,
>
> d = the diameter of the swing (tip-to-tip whirling tubes) of the available centrifuge.

C-2.3 Balance capable of weighing to 1 mg.

C-2.4 Constant temperature bath capable of being controlled at 121 ± 1ºC (250º ± 2ºF).

C-2.5 Forced circulation oven capable of being controlled at 104.4 ± 1ºC (220º ± 2ºF).

C-2.6 Desiccator, capable of holding several centrifuge tubes.

C-3 MATERIALS

C-3.1 Naphtha

C-3.2 Cleaning solution, consisting of concentrated sulphuric acid saturated with potassium dichromate.

C-3.3 Distilled Water

C-3.4 Denatured Ethyl Alcohol

C-4 PROCEDURE

C-4.1 Preparation of Centrifuge Tubes

Prepare three centrifuge tubes.

C-4.2 Support the centrifuge tubes in an upside down position in a oven maintained at 104.4 ± 1ºC (220 ± 2ºF) for at least half an hour.

C-4.3 Remove the tubes from the oven, place them in a desiccator, and permit them to cool to room temperature.

C-4.4 Number each tube and weigh it to the nearest milligram.

C-4.5 Place 320 ml of the sample into a 400 ml beaker and heat in an oven at 121 ± 1ºC (250 ± 2ºF) for 20 min.

C-4.6 Remove the beaker from the oven and allow it to cool to 25 ± 3°C. Place 100 ml or oil from the beaker in each centrifuge tube and cork the tube. Place the tubes in an upright position, still corked, in a darkened area, such as a drawer or cupboard at room temperature for a period of 30 ± 1 days.

C-4.7 Remove the tubes from the storage area, place them in a centrifuge at 1500 ± 25 rpm for a period of 30 ± 1 min. If the residue is a solid, wash it several times with naphtha, a sufficient number of times to assure that it is free of oil.

> NOTE — In transferring the centrifuge tubes from the storage area to the centrifuge, care must be taken not to disturb any material which may have separated from the oil.

C-4.8 Remove the centrifuge tubes from the centrifuge, decant, and discard the supernatant oil. Permit the centrifuge tube to drain in an upside down position at room temperature for a period of two hours.

> NOTE — If the separated material is not sufficiently compacted by the centrifuging to permit decanting the supernatant oil, continue the centrifuging for 15 min intervals until decanting is possible. If the material is a liquid at the conclusion of the centrifuge, tube and replace it in storage for an additional 30 days. At the end of the second storage period, processed as in **C-4.7**.

C-4.9 Place the centrifuge tubes in an upright position in an oven controlled at 104.4 ± 1ºC (220 ± 2ºF) for approximately two hours.

C-4.10 Remove the centrifuge tubes from the oven and place them in a desiccators to cool to room temperature. Weigh the tubes and contents to the nearest milligrams. Subtract the weight of the empty centrifuge tubes to determine the weight of the separated material.

C-4.11 If the residue remains a liquid at the end of the second 30 days storage period, centrifuge the tubes as specified in **C-4.7**. Remove the tubes from the centrifuge and note the volume of the separate liquids to the nearest 0.05 ml.

C-4.12 Calculation

C-4.12.1 Calculate the average amount of separated residue (solid/liquid) on the basis of three test samples.

C-4.12.2 Calculate the percent insoluble residue in the sample from the formula:

$$\text{Percent insoluble residue} = \frac{\text{Average amount of separated residue, g}}{0.9 \times \text{Weight percent of additive in sample}} \times 100$$

Where,

0.9 = assumed specific gravity of the sample.

NOTE — The weight percent of additive in the sample to be obtained from the manufacturer of the sample.

ANNEX D

BIBLIOGRAPHICAL REFERENCES

International Standards	*Title*
ASTM D130	Standard Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test
ASTM D 445	Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)
ASTM D892	Standard Test Method for Foaming Characteristics of Lubricating Oils
ASTM D 2983	Standard Test Method for Low-Temperature Viscosity of Lubricants Measured by Brookfield Viscometer
ASTM D5704	Standard Test Method for Evaluation of the Thermal and Oxidative Stability of Lubricating Oils Used for Manual Transmissions and Final Drive Axles
ASTM D6121	Standard Test Method for Evaluation of Load-Carrying Capacity of Lubricants under Conditions of Low Speed and High Torque Used for Final Hypoid Drive Axles
ASTM D7038	Standard Test Method for Evaluation of Moisture Corrosion Resistance of Automotive Gear Lubricants
ADTM D7450	Standard Specification for Performance of Rear Axle Gear Lubricants Intended for API Category GL-5 Service
ASTM D7452	Standard Test Method for Evaluation of the Load Carrying Properties of Lubricants Used for Final Drive Axles, Under Conditions of High Speed and Shock Loading

ANNEX E

(*Foreword*)

COMMITTEE COMPOSITION

Lubricants and their Related Products Sectional Committee, PCD 25

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(*Continued from second cover*)

In this revision the channel point test has been removed which was previously been accepted for determining low temperature properties of a gear lubricant is outdated and is superseded by Brookfield Viscosity test. Until an equivalent IS method of Brookfield Viscosity test is developed, ASTM D2983 method may be referred to. The Committee decided to remove the Qualification Approval from the standard as it is not relevant.

Kinematic viscosity is now mentioned in mm^2/s (SI units) instead of cSt and 1 mm^2/s is equal to 1 cSt.

The composition of the technical committee responsible for the formulation of this standard is given in Annex E.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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